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The Carboniferous System. Use of the new official names for the subsystems, series, and stages.

P.H. HECKEL [1] and G. CLAYTON [2]

[1] Chair of SCCS. Department of Geoscience. University of Iowa
Iowa City, IA 52242. Email: philip-heckel@uiowa.edu

[2] Vice Chair of SCCS. Department of Geology. Trinity College Dublin
Dublin 2, Ireland. Email: gclayton@tcd.ie

ABSTRACT

As a result of votes by the Subcommission on Carboniferous Stratigraphy [SCCS] that were ratified by the International Commission on Stratigraphy [ICS] and the International Union of Geological Sciences [IUGS] over the period 1999-2004, the official subdivision of the Carboniferous System has been substantially modified. For subsystems, the terms Mississippian and Pennsylvanian should be used in all regions of the world to replace the more ambiguous and more awkward terms Lower and Upper Carboniferous. Regional geographic names for series and stages may continue to be used in those regions in which they developed, specifically in Western Europe, the USA, and China. However, their global equivalents should be denoted equally, particularly as they become better correlated, in order to facilitate global correlation in future work. The SCCS also voted to standardize the scale of all regional units termed stages at rough equivalency with the global stages now recognized in the Carboniferous (which are similar in scale to those in the adjacent Devonian and Permian Systems). Therefore, the up to 26 subdivisions of the Tournaisian, Visean, Namurian, Westphalian and Stephanian of the regional western European classification should now be ranked and termed only as substages.

KEYWORDS | Carboniferous. Chronostratigraphy. Stages. Series. Subsystem. System.

INTRODUCTION

A long task of harmonization, modification and search of general agreement carried out by the Subcommission on Carboniferous Stratigraphy (SCCS) of the International Commission on Stratigraphy (ICS) has finally led to propose the adoption of unambiguous and global chronostratigraphic subdivisions for the Carboniferous system. This short communication aims at showing clearly the proposed modifications and making as smooth as possible the transition to the new official subdivision of the Carboniferous System that includes the names for its subsystems, series and stages.

THE PROCESS OF MODIFICATION

During late 1999, the Subcommission on Carboniferous Stratigraphy (SCCS) of the International Commission on Stratigraphy (ICS) voted 13 to 4 to adopt the established unambiguous American names Mississippian and Pennsylvanian as the official designations for the two subsystems of the Carboniferous System. These names should be substituted for the ambiguous terms Lower Carboniferous and Upper Carboniferous, respectively, which have been used with several different definitions elsewhere in the world. The American subsystem names were selected over the western European subsystem

<table>
<tr><th>SYSTEM</th><th>SUB-SYSTEM</th><th>GLOBAL SERIES</th><th>GLOBAL STAGE [Eastern Europe]</th><th>Regional Stage North America</th><th colspan="2">Regional Stage Western Europe</th><th>Regional Stage China</th></tr>
<tr><td rowspan="12">CARBONIFEROUS</td><td rowspan="6">PENNSYLVANIAN</td><td rowspan="3">UPPER</td><td>GZHELIAN</td><td>Virgilian</td><td colspan="2">Autunian [lower]</td><td rowspan="2">Xiaodushanian</td></tr>
<tr><td rowspan="2">KASIMOVIAN</td><td>Missourian</td><td rowspan="2">Stephanian</td><td rowspan="5">SILESIAN</td></tr>
<tr><td rowspan="2">Desmoinesian</td><td rowspan="3">Dalaun</td></tr>
<tr><td rowspan="2">MIDDLE</td><td rowspan="2">MOSCOVIAN</td><td rowspan="2">Westphalian</td></tr>
<tr><td>Atokan</td><td rowspan="2">Huashibanian</td></tr>
<tr><td>LOWER</td><td>BASHKIRIAN</td><td>Morrowan</td><td rowspan="2">Namurian</td></tr>
<tr><td rowspan="6">MISSISSIPPIAN</td><td>UPPER</td><td>SERPUKHOVIAN</td><td>Chesterian</td><td>Luosuan</td></tr>
<tr><td rowspan="2">MIDDLE</td><td rowspan="2">VISEAN</td><td>Meramecian</td><td rowspan="2">Visean</td><td rowspan="5">DINANTIAN</td><td>Dewuan</td></tr>
<tr><td rowspan="2">Osagean</td><td>Shangsian</td></tr>
<tr><td rowspan="3">LOWER</td><td rowspan="3">TOURNAISIAN</td><td>Jiusian</td></tr>
<tr><td>Kinderhookian</td><td>Tournaisian</td><td>Tangbagouan</td></tr>
</table>

FIGURE 1 | **Chart showing recently ratified global subdivision of Carboniferous System and approximate equivalency of global subdivisions to regional stage subdivisions in North America (specifically midcontinent United States), western Europe, and China. Regional stages in North America were originally introduced as series of the Mississippian and Pennsylvanian Systems, but have become increasingly regarded as stages. Regional stages indicated for western Europe have always been regarded as series and were grouped into the Dinantian Subsystem (Tournaisian + Visean) and Silesian Subsystem (Namurian + Westphalian + Stephanian), but are ranked here as stages because their many component stages have been lowered in rank to substages to keep the scale of subdivisions similar in the regional and global classifications for the Carboniferous and adjacent systems. Correlation of the regional scales with the global scale are taken from many sources, summarized by P.L. Brenckle and H.R. Lane in Heckel, ed. (2001) for the Mississippian of North America, by Heckel (2003) for the Pennsylvanian of North America and western Europe, and by Wang and Jin (2003) for China. Dashed lines separating the Moscovian and Kasimovian Stages (and Middle and Upper Pennsylvanian Series) reflect the range of uncertainty of the level at which the event defining that boundary will be chosen (Villa and Task Group, 2004).**

names Dinantian and Silesian because the previously selected Mid-Carboniferous subsystem boundary coincides with the traditional Mississippian-Pennsylvanian boundary, but lies two substages above the traditional Dinantian-Silesian boundary at the Visean-Namurian boundary. This decision was ratified by the ICS and by the International Union of Geological Sciences (IUGS) in early 2000, as reported in the SCCS Secretary-Editor's Report in the July 2000 edition of the Newsletter on Carboniferous Stratigraphy (Metcalfe, 2000).

More recently, during late 2003, the SCCS voted 14 to 3 with 2 abstentions to subdivide the two above-mentioned subsystems into Lower, Middle, and Upper Mississippian Series and Lower, Middle, and Upper Pennsylvanian Series. These series boundaries coincide with the boundaries of the western and eastern European-named stages used in Russia, which are the names that will now be used for global stages. This decision, as reported in the SCCS Secretary-Editor's Report in the July 2004 edition of the Newsletter on Carboniferous Stratigraphy (Work, 2004), was ratified by the ICS and IUGS in early 2004. Although not as hierarchical as in other systems, this series terminology is flexible, because if any of the longer stages are later subdivided into two or more globally recognized stages, then the current stage name would be elevated in rank to series with equivalency to the positional series name. For example, if it could be subdivided, the Visean Stage would become the Visean Series, which would equal the Middle Mississippian Series (just as it does as a stage), and it would comprise the two new stages, which would receive new names.

During late 2003, the SCCS also voted to withdraw official recognition of the rank of stage from the units

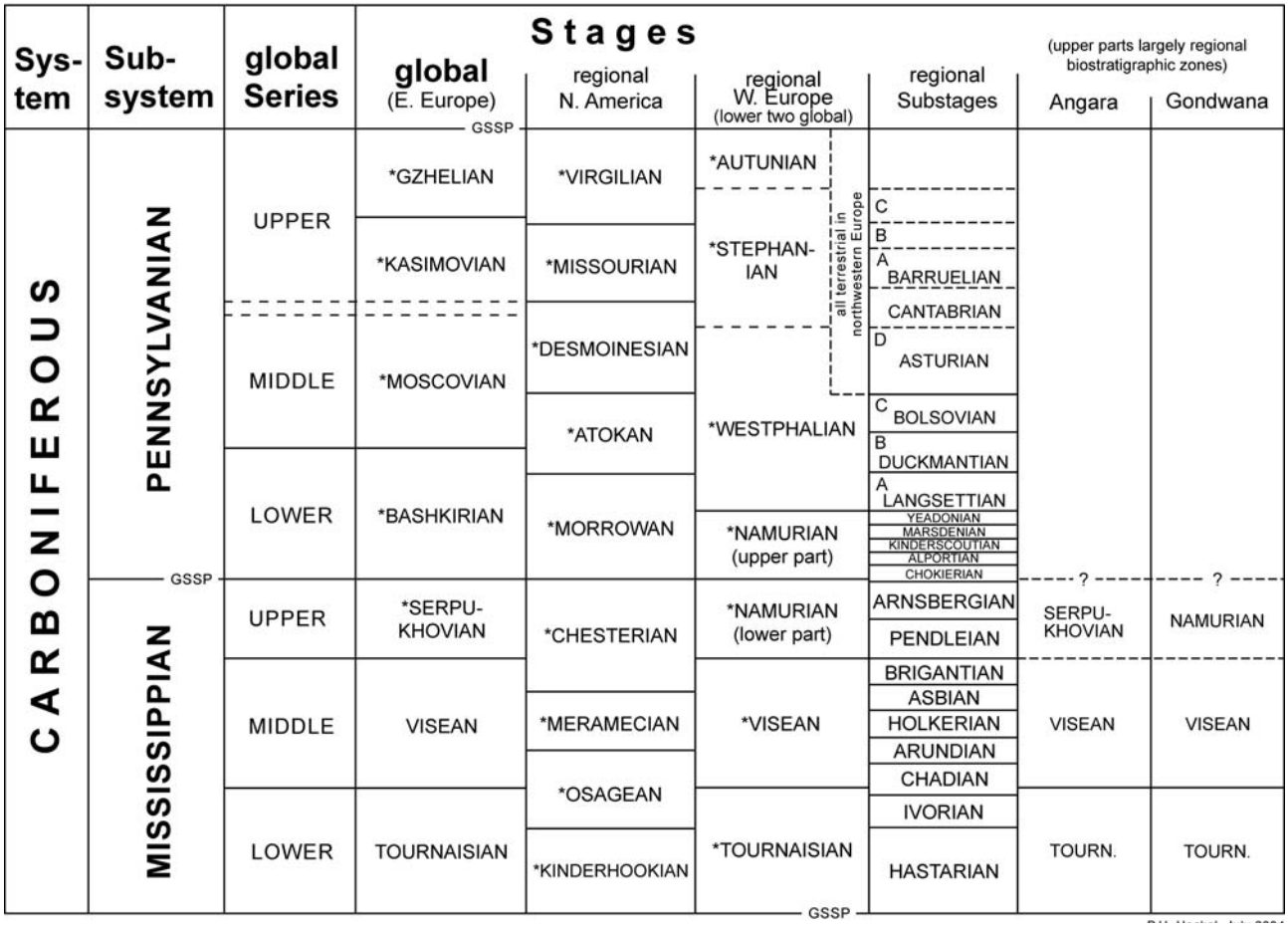

FIGURE 2 | **Chart showing recently ratified global series and stage subdivision of Carboniferous System, with approximate equivalency of global subdivisions to regional stage subdivisions in North America and to regional stage (formerly series) and substage (formerly stage) subdivisions in western Europe. Belgian substage names are shown for Tournaisian, and British substage names are shown for Visean. Relative positions of Mississippian regional stage and substage boundaries were provided by D.M. Work. Dashed lines separating Moscovian and Kasimovian Stages (and Middle and Upper Pennsylvanian Series) reflect the range of uncertainty of the level at which the event defining that boundary will be chosen (Villa and Task Group, 2004). Dashed lines in regional columns reflect uncertainty of correlation with global stages.**

into which the 5 regional western European series have traditionally been subdivided. This in effect reduces the rank of these smaller units to that of substage, in order to keep the scale of units termed stages roughly equivalent to that of the global stages now recognized not only in the Carboniferous but also in the adjacent Devonian and Permian Systems. Therefore, the 15 subdivisions of the Namurian, Westphalian and Stephanian divisions of the regional western European classification (Pendleian, Arnsbergian, Chokierian, Alportian, Kinderscoutian, Marsdenian, Yeadonian, Langsettian, Duckmantian, Bolsovian, Westphalian D/Asturian, Cantabrian, Barruelian, Stephanian B, and Stephanian C), and the up to 11 subdivisions of the Tournaisian and Visean Stages defined from Britain (Courceyan, Chadian, Arundian, Holkerian, Asbian, Brigantian) and Belgium (Hastarian, Ivorian, Moliniacian, Livian, Warnantian) should now be ranked and termed only as substages.

PROPOSALS FOR THE USAGE OF THE NEW CARBONIFEROUS CLASSIFICATION

In order to stabilize international terminology of the geological time scale, it is now appropriate for journals of international distribution and reputation to encourage and ultimately require usage of the new Carboniferous classification. To facilitate this transition, we offer the following suggestions:

Subsystems usage

For subsystems, the terms Mississippian and Pennsylvanian should be used in all regions of the world to replace the more ambiguous and more awkward terms Lower and Upper Carboniferous. (The terms Lower Carboniferous and Upper Carboniferous are particularly awkward when reference is made to their lower or upper parts.) Use of the western European regional subsystem

names (Dinantian and Silesian) is now unnecessary and should be discouraged because the Mississippian-Pennsylvanian [Mid-Carboniferous] boundary can be recognized within the substage succession in the Namurian. If the terms Lower and Upper Carboniferous or Dinantian and Silesian were previously used in a particular area, they should be noted (in parentheses) after the new terms at first mention in the text, in order to connect the reader with the previous literature. Of course, if the author cites an older reference within the text of any article, for example, that Smith (1985) identified a unit as Upper Carboniferous or Silesian, that designation should be retained in that statement because that is what that author stated at that time, but it would be desirable to follow that designation with the official term [Pennsylvanian] in brackets. Also, when referring informally to relative positions or time within the Carboniferous, use of the uncapitalized terms early/lower and late/upper are acceptable, as for example "…during late Carboniferous time".

Regional geographic names for series and stages

Regional geographic names for series and stages may continue to be used in those regions in which they developed, specifically in Western Europe, the USA, and China. However, their global equivalents should be denoted equally, particularly as they become better correlated, in order to facilitate global correlation in future work. In order to simplify this transition, we include charts (Figs. 1 and 2) that provide the latest general equivalency of the global and regional terms. Although the final definitions of the stage/series boundaries within the two subsystems have not yet been completed, most of the levels will very likely be close to the boundaries shown on the charts. The best level for the base of the Kasimovian Stage (and the Upper Pennsylvanian Series) with respect to the Desmoinesian-Missourian regional stage boundary in the USA has not yet been selected.

Standardization of the scale of all regional stages at equivalency with the global stages

The SCCS also voted to standardize the scale of all regional units termed stages at rough equivalency with the global stages now recognized in the Carboniferous (which are similar in scale to those in the adjacent Devonian and Permian Systems). Therefore, the up to 26 subdivisions of the Tournaisian, Visean, Namurian, Westphalian and Stephanian of the regional western European classification should now be ranked and termed only as substages. This includes the Pendleian, Arnsbergian, Chokierian, Alportian, Kinderscoutian, Marsdenian, and Yeadonian in the Namurian, the Langsettian, Duckmantian, Bolsovian, and Westphalian D/Asturian in the Westphalian, the Cantabrian, Barruelian, Stephanian B, and Stephanian C in the Stephanian, the Courceyan, Chadian, Arundian, Holkerian, Asbian, and Brigantian in the Tournaisian and Visean of Britain, and the Hastarian, Ivorian, Moliniacian, Livian, and Warnantian in the Tournaisian and Visean of Belgium.

SUMMARIZING REMARKS

As a result of votes by the Subcommission on Carboniferous Stratigraphy [SCCS] that were ratified by the International Commission on Stratigraphy [ICS] and the International Union of Geological Sciences [IUGS] over the period 1999-2004, the official subdivision of the Carboniferous System is, in descending order (as is now shown at the website of the ICS at www.stratigraphy.org/gssp.htm):

CARBONIFEROUS SYSTEM
PENNSYLVANIAN SUBSYSTEM
UPPER PENNSYLVANIAN SERIES
Gzhelian Stage
Kasimovian Stage
MIDDLE PENNSYLVANIAN SERIES
Moscovian Stage
LOWER PENNSYLVANIAN SERIES
Bashkirian Stage
MISSISSIPPIAN SUBSYSTEM
UPPER MISSISSIPPIAN SERIES
Serpukhovian Stage
MIDDLE MISSISSIPPIAN SERIES
Visean Stage
LOWER MISSISSIPPIAN SERIES
Tournaisian Stage

We would like to encourage this newly ratified global classification of the Carboniferous System in order to expedite the worldwide standardization of geologic nomenclature. We hope that the considerations suggested above and the general correlation charts provided will make the transition as smooth as possible.

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